

NOTES ON THE VARIABILITY OF *MICROCTONUS AETHIOPOIDES* LOAN
(HYMENOPTERA : BRACONIDAE : EUPHORINAE)

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Abstract

Laboratory experiments and field observations reveal that there is a number of geographical as well as host-associated biotypes of *M. aethiopoulos*. Parasitoids obtained in Mediterranean France from *H. postica* have three, from *S. discoideus* five yearly generations as compared with two only in continental areas. The biotypes differ not only in their bionomics (number of generations, period of emergence, duration of pupal stage), but also in their morphology (average number of flagellar segments) and coloration. The effect of temperature on pupal development and coloration of female *M. aethiopoulos* is described and the practical implication of these observations in terms of biological control is discussed.

INTRODUCTION

Most species of the genus *Microctonus* Wesmael oviposit in adult Coleoptera in which the larva develops as an endoparasitoid, usually sterilizing and then killing its host. Because of their potential importance for biological control, several representatives of the genus have been recommended for use against a number of chrysomelid and curculionid pest species (Smith 1952, 1953; Loan 1960, 1967, 1975; Drea *et al.* 1972; Dysart and Day 1976; Aeschlimann 1978; Harcourt *et al.* 1979).

Investigations began in 1973 at the Montpellier station of CSIRO to find efficient natural enemies of *Sitona discoideus* Gyllenhal (Col., Curculionidae), a weevil that had recently become accidentally established in South-East Australia and assumed pest proportions in fields of *Medicago* spp. The euphorine *Microctonus aethiopoulos* Loan was found to be the predominant parasitoid of *Sitona* weevil in the Mediterranean region and was considered to be the most promising biological control agent for introduction into Australia. Rearing of the Braconid was initiated in 1974 at Montpellier and in 1976-77 at Canberra and Adelaide after importation into Australia (Cullen and Hopkins 1982). This paper describes some characteristics of Mediterranean *M. aethiopoulos* biotypes and compares these with findings by other researchers in Central Europe and North America.

MATERIAL AND METHODS

The techniques used to collect and record the host weevils and their natural enemies have been described by Aeschlimann (1978, 1979).

At Montpellier, *M. aethiopoulos* was mass-reared in polystyrene containers used for culturing *Sitona* (Aeschlimann 1978). The procedure was simplified by replacing potted lucerne (*Medicago sativa* Linnaeus) plants with several cut stems of lucerne (30-40 cm long) in each rearing unit. Cotton wool was tied around the stems 6-8 cm above the cut ends. The stems were then placed into a polystyrene tube (8 cm long, 3 cm diameter) filled with tap water. The open end of the tube was sealed with "Parafilm" just above

the ring of cotton wool. Water was added as required through a hole in the upper side of the tube. From June to August, the majority of cut stems developed a dense root system in the tube, making replacement of the host plant unnecessary for several months.

The rearing units used at Canberra have been described by Cullen and Hopkins (1982).

Adult *M. aethiopoides* for use in coloration studies were obtained at Canberra by maintaining three groups of freshly spun cocoons at constant temperatures of 10, 19 and 28°C and checking each group daily for emergence (the photoregime and relative humidity in the three growth chambers were similar).

SPECIFICITY AND VOLTINISM

There are several erroneous records in the lists of hosts published by Smith (1953), Shenefelt (1969) and Neal (1970) for *M. aethiops* auct. In a taxonomic revision of this group of euphorines, Loan (1975) showed that a number of *Microctonus* species had been misidentified as *M. aethiops* auct., and that the only hosts of *M. aethiopoides* were in fact species of the genera *Hypera* Schönherr and *Sitona* Germar (Col., Curculionidae). The following observations suggest that specificity in the field may be even greater.

In Mediterranean France, the dominant curculionid species in lucerne growing areas are *S. discoideus* and the alfalfa weevil *Hypera postica* Gyllenhal, an almost cosmopolitan pest of cultivated lucerne and also a potential threat to Australian agriculture. The two weevils are parasitized by *M. aethiopoides*, but two distinct biotypes of the parasitoid may be recognized at sites where both species are abundant. These biotypes differ in several aspects of their biology and morphology, although they are not strictly specific in terms of hosts selection. When provided with a choice under laboratory conditions, females show a preference for one host species, but they will oviposit in both hosts in a no-choice situation. However, the differing life cycles of the weevil species contribute towards the segregation of the two different biotypes of *M. aethiopoides*.

Microctonus spp. are generally passing through one generation per year, although several Palearctic as well as Nearctic representatives of the genus may have two, sometimes three, and exceptionally even four generations per annum (Delucchi 1952; Smith 1952 *pro errore*; Jourdheuil and Chansigaud 1961; Coles and Puttler 1963; Loan 1960, 1967, 1975; Neal 1970; Drea *et al.* 1972; Dysart and Day 1976; Luff 1976; Harcourt *et al.* 1979; Wylie 1980). The period over which sexually immature hosts are present in the field largely determines the number of parasitoid generations, as such hosts inhibit the development of first-instar *Microctonus* larvae. In temperate areas the curculionid hosts of *M. aethiopoides* emerge during summer, and hibernate before laying most of their eggs in the following spring. Under Mediterranean climatic conditions, adults of *S. discoideus* and *H. postica* emerge towards the end of spring, and aestivate before becoming sexually reproductive in early autumn (cf. Fig. 1). The bionomics of the host permits the biotype infesting *S. discoideus* to complete three generations between March and June (Fig. 1), with a further two generations from September to December in parts of the French Aude, Hérault and Gard départements which have a Mediterranean climate. In the same

localities, the biotype attacking *H. postica* also produces three generations during spring, but with different emergence periods of adults as Figure 1 shows; so far no *M. aethioides* adult was ever obtained from *H. postica* in autumn rearings.

According to Loan (1975), a deviation of ± 1 from the average number of flagellar segments of the female antennae occurs in most species of the genus *Microctonus*. Adults of *M. aethioides* obtained from the two host species differ significantly in this respect (Table 1), with an overlap occurring in no more than 3 % of the females.

Table 1. VARIATION IN THE NUMBER OF FLAGELLAR SEGMENTS OF FRENCH *M. aethioides*.

Host species	Sex of <i>M. aethioides</i>	Proportion of <i>M. aethioides</i> (%) with following number of segments											
		18	19	20	21	22	23	24	25	26	27	28	29
<i>S. discoideus</i>	♀	16.1	81.5	2.4									
<i>H. postica</i>	♀			3.6	57.1	35.7	3.6						
<i>S. discoideus</i>	♂					5.0	21.7	33.3	28.3	11.7			
<i>H. postica</i>	♂								3.6	57.1	35.7	3.6	3.6

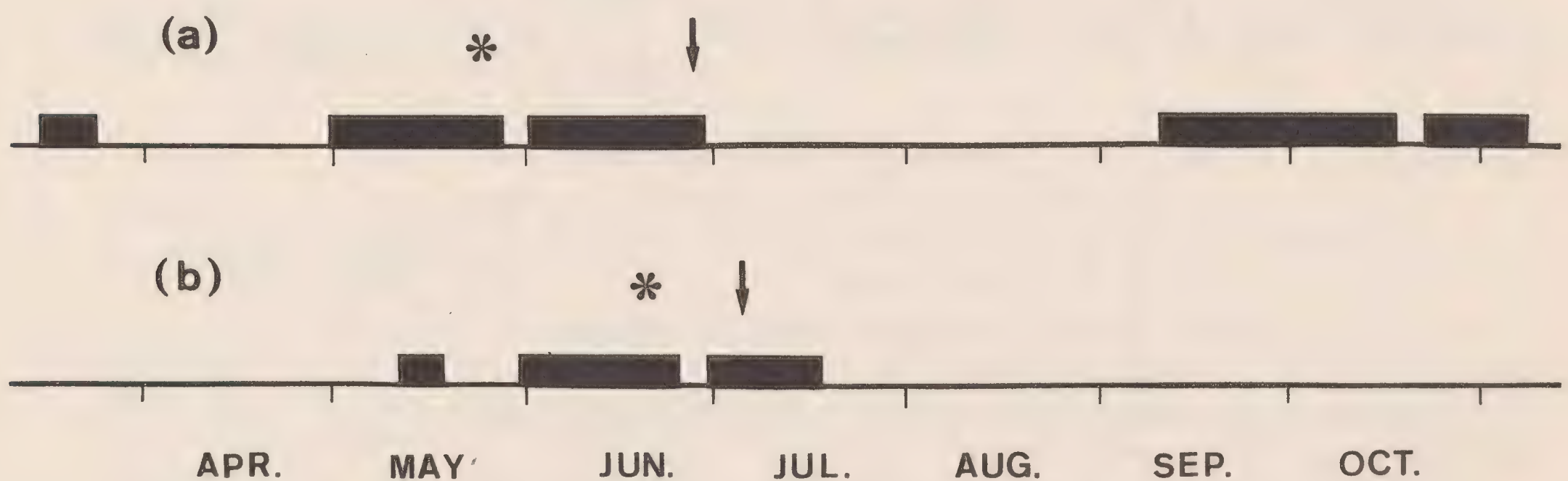


Fig. 1. Emergence periods of adult *M. aethioides* in cultivated lucerne plots of Mediterranean France. (a) from *S. discoideus*. (b) from *H. postica*. (*) beginning of new weevil generation emergence. (↓) end of overwintered weevil generation.

PUPAL DEVELOPMENT AND COLORATION

Two biotypes of *M. aethioides*, one from a warm and dry area in southern Morocco and the other from a cooler locality in central Greece have been released against *S. discoideus* in Australia (Cullen and Hopkins 1982).

Females from both areas show distinct seasonal variations in coloration. The head and thorax of individuals emerging in late spring and early autumn are orange-colored while females produced in early spring and late autumn are blackish. Males remain black-colored throughout the season. The most characteristic changes in coloration of female *M. aethiopoides* occur on the frons and thorax (Table 2). Moroccan females tend to be somewhat lighter in color than those of Greek origin. The biotypes differ also in the duration of the pupal stage (Table 2). These results are supported by preliminary electrophoretic analyses (W. J. Davidson, pers. comm.) which indicate that there is a consistent difference in the pattern of non-specific esterases between Moroccan and Greek specimens - despite individual variations due to age, sex, and the temperature at which parasitoids are reared.

Table 2. EFFECT OF TEMPERATURE DURING PUPAL STAGE ON COLORATION OF FEMALE *M. aethiopoides*.

Biotype	Temperature (°C)	Mean pupal time and extremes (d)		Coloration of female <i>M. aethiopoides</i>				
		♂	♀	Frons	Pronotum	Mesopleurum	Mesoscutum	Scutellum
Greek	10 ± 1	27 (26-28)	31 (29-34)	black area around ocellae	black	dark, lower 0.6 lighter	dark	dark
	19 ± 1	10 (10)	10 (9-11)	black spot betw. ocellae	light	reddish-brown, dark line along upper carina	dark, median 0.3 red-brown	dark
	28 ± 1	6 (5-7)	7 (6-8)	dark line betw. ocellae	light	light	dark, median 0.6 reddish-brown	dark, brown spot on median 0.3
Moroccan	10 ± 1	18 (18)	27 (24-30)	black spot betw. ocellae	dark, upper 0.2 reddish	dark, lower 0.6 lighter	dark	dark
	19 ± 1	7 (7)	8 (8)	dark line betw. ocellae	light	light	light, dark lateral spot	dark
	28 ± 1	5 (4-6)	5 (5)	completely light	light	light	light	light, apical 0.2 lighter

DISCUSSION

Apart from Delucchi's (1952) brief account of *M. emmae* Delucchi in southern Italy, *M. aethiopoides* is the first species of the genus to be studied in its Mediterranean distribution range. Mediterranean biotypes of *M. aethiopoides*, passing through five annual generations, are more likely to achieve some degree of control of *S. discoideus* pest populations than those from continental areas of Central Europe and North America which only have

two yearly generations. Differences between biotypes originating from various parts of the Mediterranean region also have to be considered; the shorter developmental duration of Moroccan pupae (cf. Table 2) as compared with those of Greek origin for instance may confer a distinct advantage on the former biotype in the field. These observations on the biotypes of *M. aethiopoides* support the hypothesis (Townes 1971) that exploration for efficient biological control organisms should be concentrated on areas with a climate as dry and warm, or preferably drier and warmer, than that in the area of release.

In our laboratory rearings, mortality of *M. aethiopoides* larvae of the various biotypes within their hosts never exceeded 2 %. This contrasts with the failure (through encapsulation, inability to emerge, non-establishment) to rear and introduce *M. aethiopoides* elsewhere (Loan 1960, Coles and Puttler 1963, Clancy 1969, Neal 1970) probably due to the selection of a biotype poorly adapted to the climatic conditions prevailing in the release area or primarily parasitizing a weevil species other than the target host.

As has been suggested for the *Sitona* species infesting *Medicago* spp. in the Palearctic region (Aeschlimann 1983), the biotypes of *Microctonus* parasitizing *Sitona* weevils may be undergoing speciation due to the continuous selection pressure of climate, geographical isolation, and restriction to a particular host species in recently colonized territories.

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RÉSUMÉ

Notes sur la variabilité de *Microctonus aethiopoides* Loan (Hymenoptera, Braconidae : Euphorinae)

Expériences au laboratoire et observations en nature permettent de conclure à l'existence de différents biotypes de *M. aethiopoides*. Les divergences entre ces biotypes sont essentiellement fonction de l'origine géographique et de l'hôte préférentiel. Ceux qui évoluent en France sous un régime climatique méditerranéen ont cinq générations annuelles sur *S. discoideus*, mais trois seulement sur *H. postica*; sous un climat tempéré en revanche, les parasitoïdes de ces mêmes hôtes n'ont que deux générations annuelles en Europe centrale et en Amérique du Nord. Les biotypes diffèrent non seulement par le voltinisme, mais également par les périodes d'émergence des diverses générations, la durée moyenne du stade nymphal, le nombre moyen de segments du flagelle, la coloration corporelle des femelles et la distribution des estérases obtenue par électrophorèse. L'influence de la température sur le développement nymphal et la coloration des femelles de *M. aethiopoides* est décrite. Les conséquences pratiques de ces observations pour la lutte biologique contre les Curculionides-hôtes sont discutées.

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